V-22 - ITV TRANSPORTABILITY

NAVAL AIR SYSTEMS COMMAND

AIR-4.3.5.4 Mechanical Systems Branch

Internal Cargo / Rescue Hoist / Spec. Ops Competency

V-22B - ITV TRANSPORTABILITY

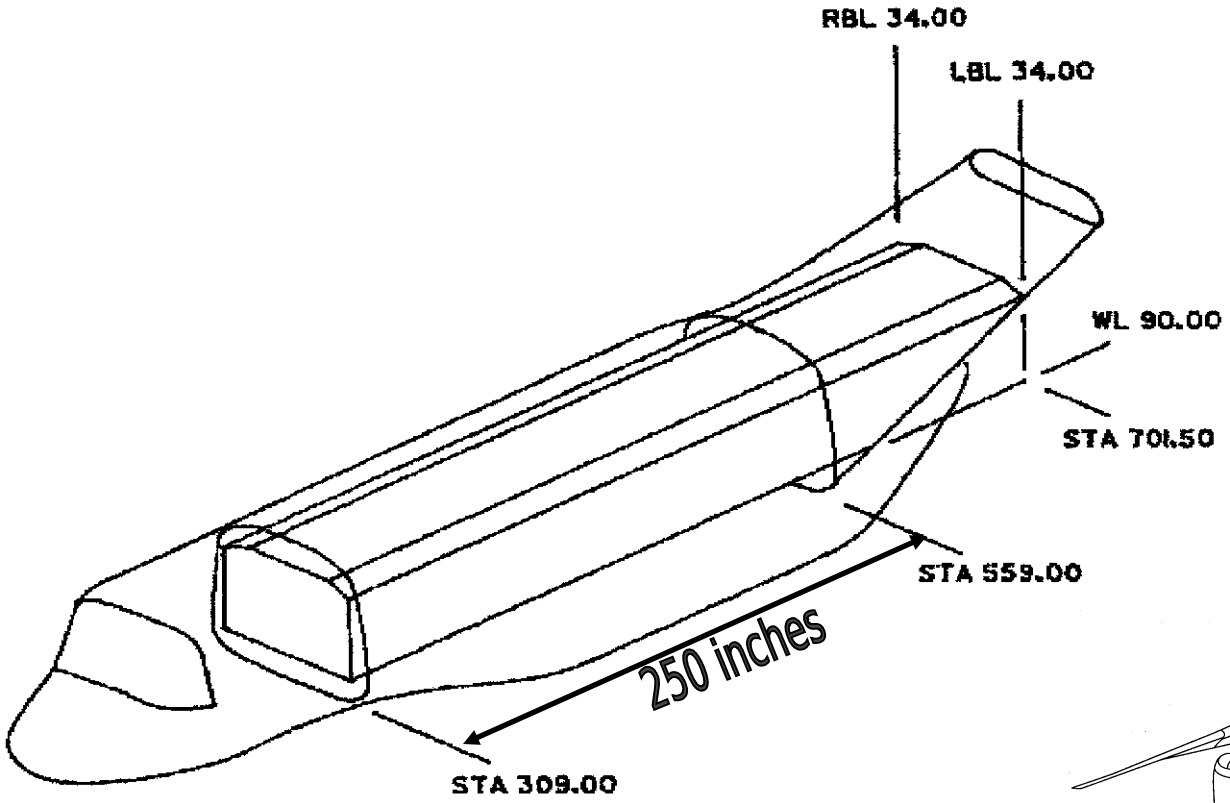
Competency Aligned Organization / Functional Product Areas

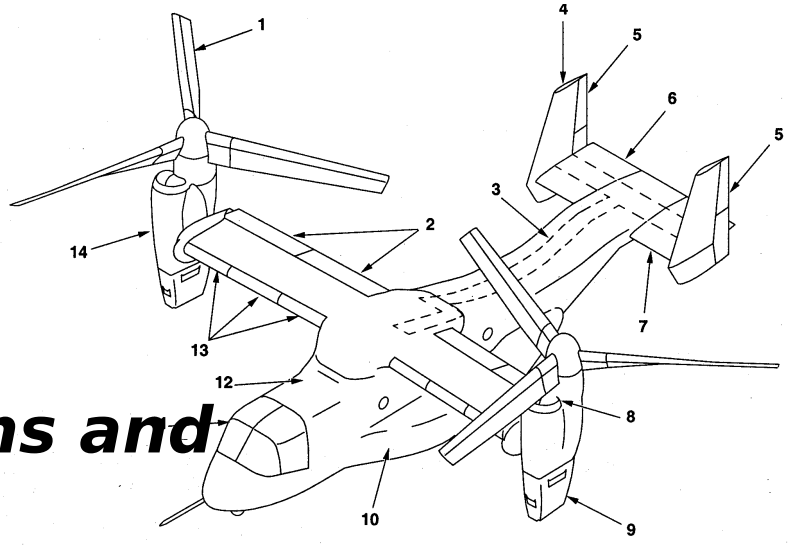
AIR-4.3.5.4 is the collector of information for air-transportability

* *Specialty niche is tiedown restraint and dimensional constraints*
* *Limits/Restrictions are also set by others - our goal is to keep within those restraints*

* *The others (not all inclusive):*
  - *Loads and Dynamics*
  - *Strength*

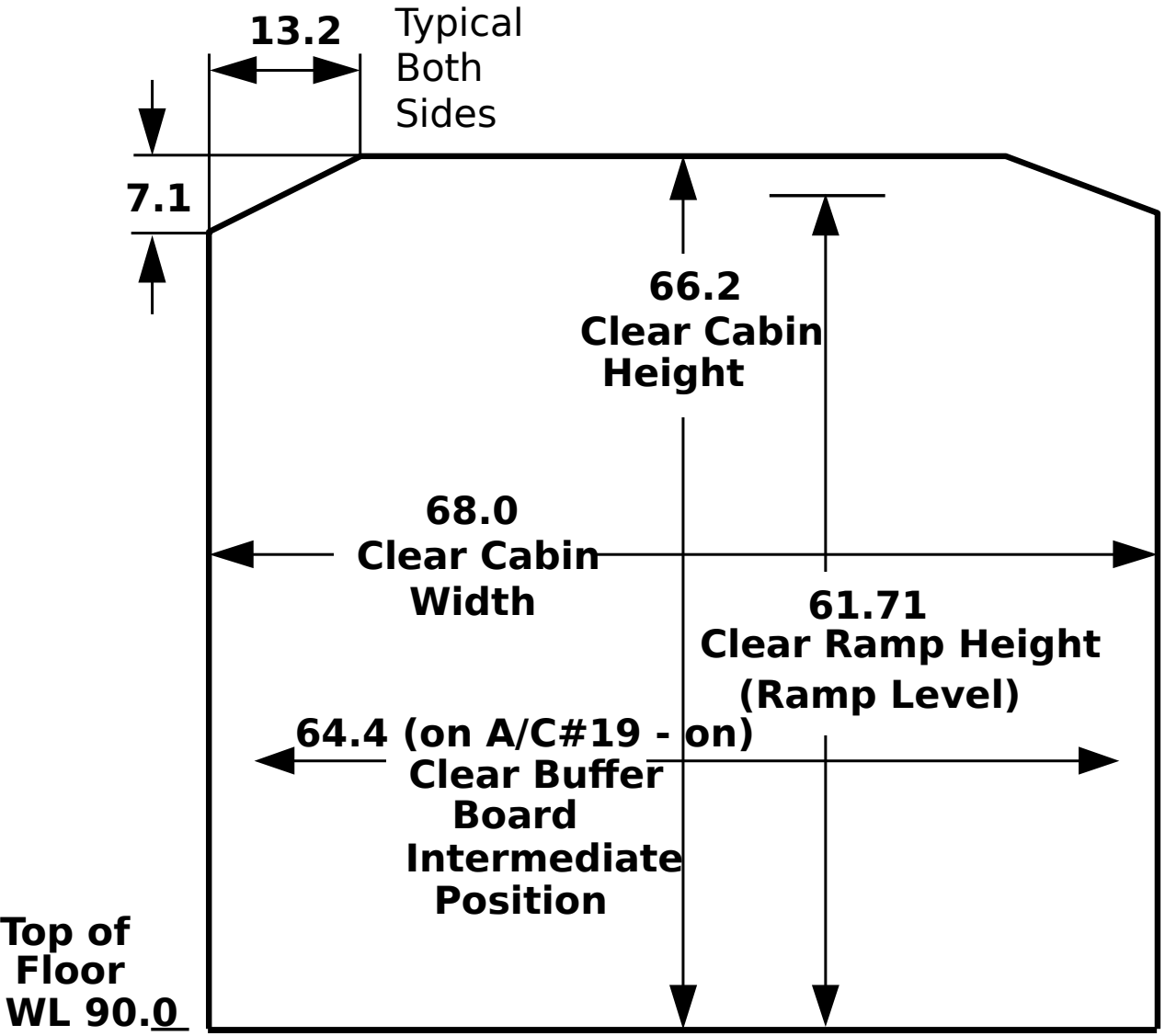
V-22B - ITV TRANSPORTABILITY





OVERALL CABIN LENGTH "generic-in-nature" without tailoring to specific cargo items and mission configurations

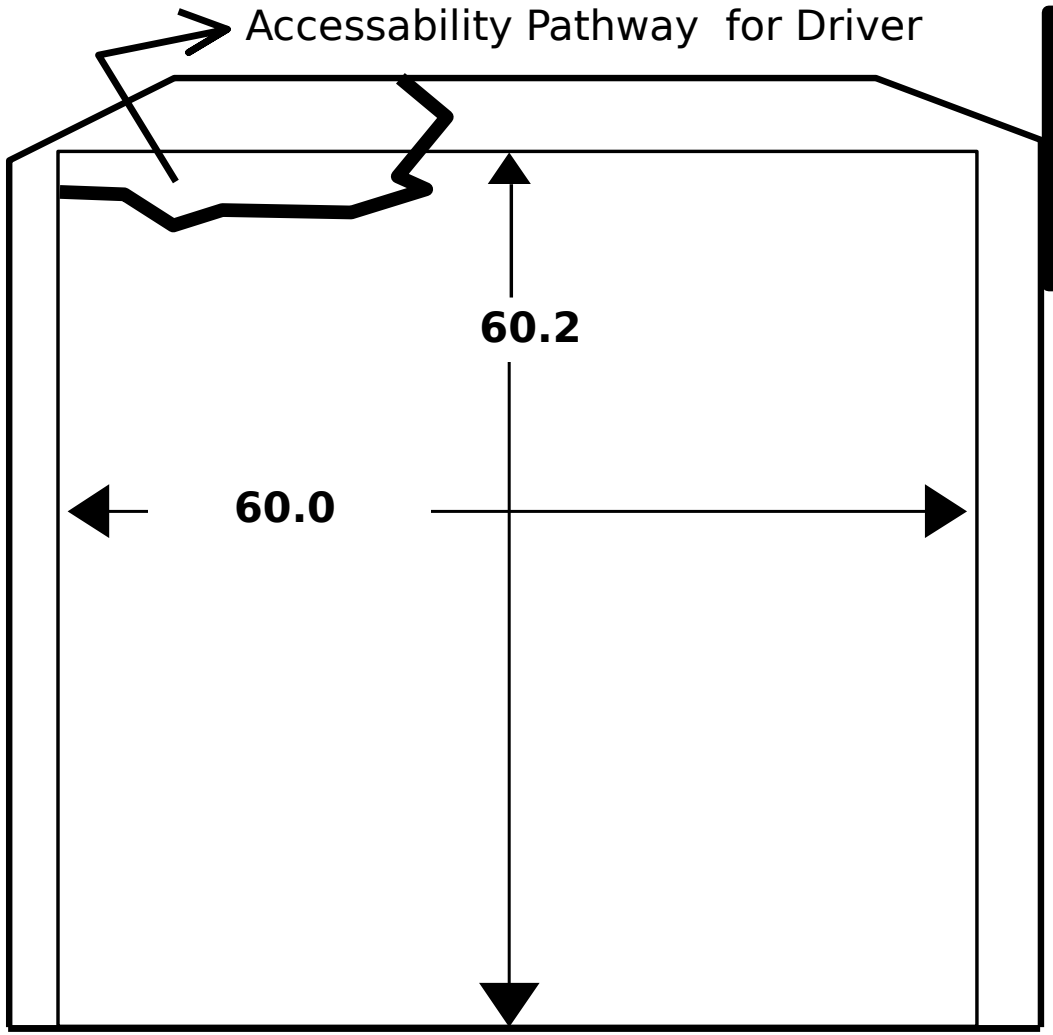
V-22B - ITV TRANSPORTABILITY



Length - 250 inches

CARGO ENVELOPE "generic-in-nature" without tailoring to specific cargo items and mission configurations

V-22B - ITV TRANSPORTABILITY



ITV Length -
180 - 4 crew
200 3-crew

Length needs to include tiedown strap length/angles

THE ITV "BOX"

V-22B - ITV TRANSPORTABILITY

DOES THIS MEAN YOU CAN FILL THAT ENTIRE "ITV BOX"

NO !

The 60-inch width should be subject to a review of all profiles and outer mold lines (OML) of the vehicle prior to acceptance of the vehicle on the V-22 for internal carriage.

As seen by the John Deere MGator fit, a small field of view angle will not allow the crewchief and the driver to communicate effectively. Profiles, such as jerry can racks on the front hood of a vehicle, which can cause a small field of view, should be avoided in designs.

The turned tire of any wheeled vehicle, being outside the OML of the vehicle while making small alignment adjustments on the ramp and cabin causes increases workload to the aircrew. More eyes are needed to watch all the critical strike areas in the cabin or a slower loadex evolution occurs.

Therefore, a 60-inch wide vehicle may still be unacceptable if proper

FIELD OF VIEW

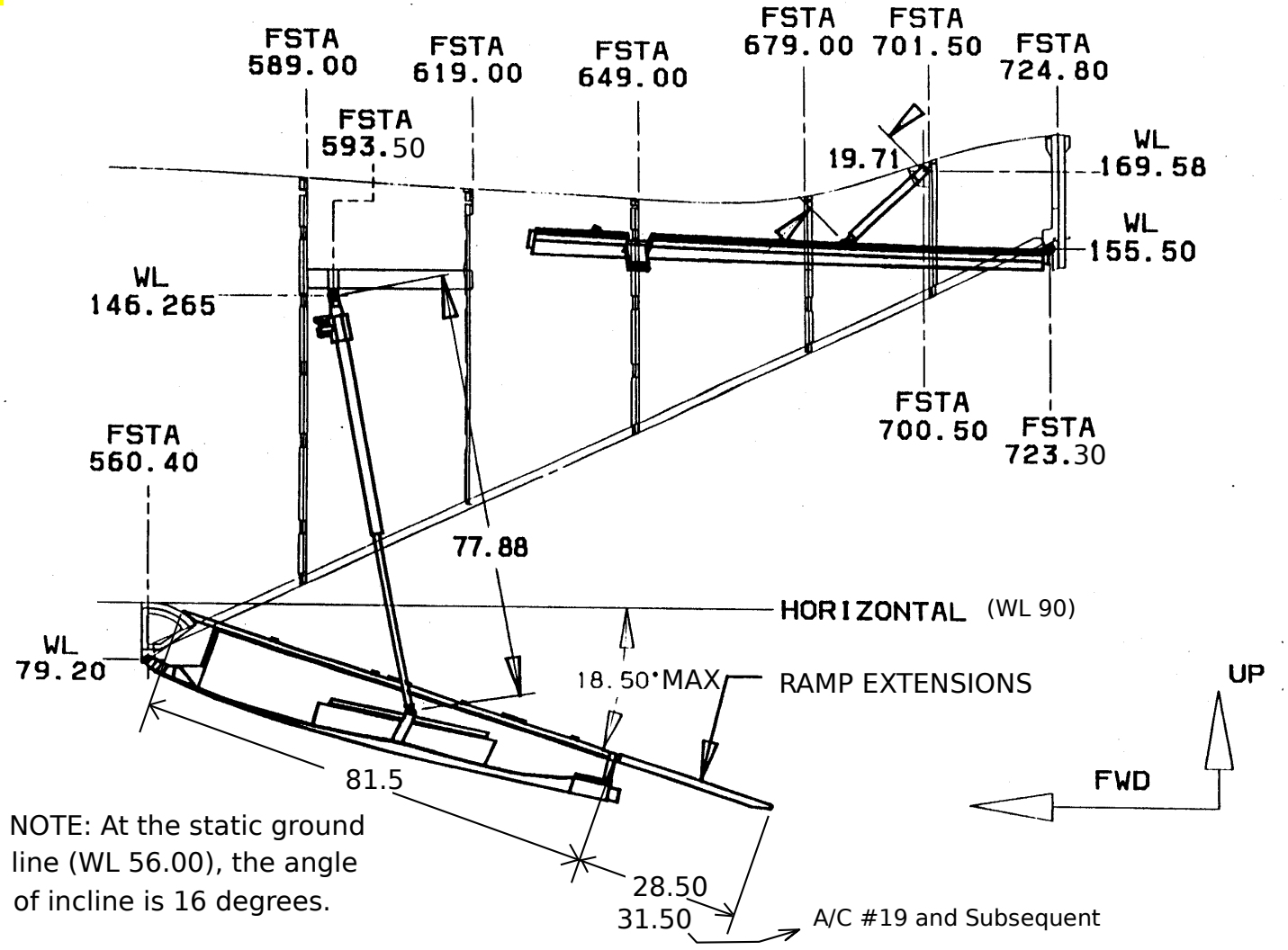
Vehicle	Seat Pos.	Eye Ht.	Field of View (degrees down) Fwd
Polaris Sportsman	Center	64	17
Polaris Ranger	Left	61	28
JD Gator	Left	53.5	4.5
"Zamboni" test bed	Center	62.5	13

Poor Field of View

- driver standing to see aircrew or visual aids for NVG loading

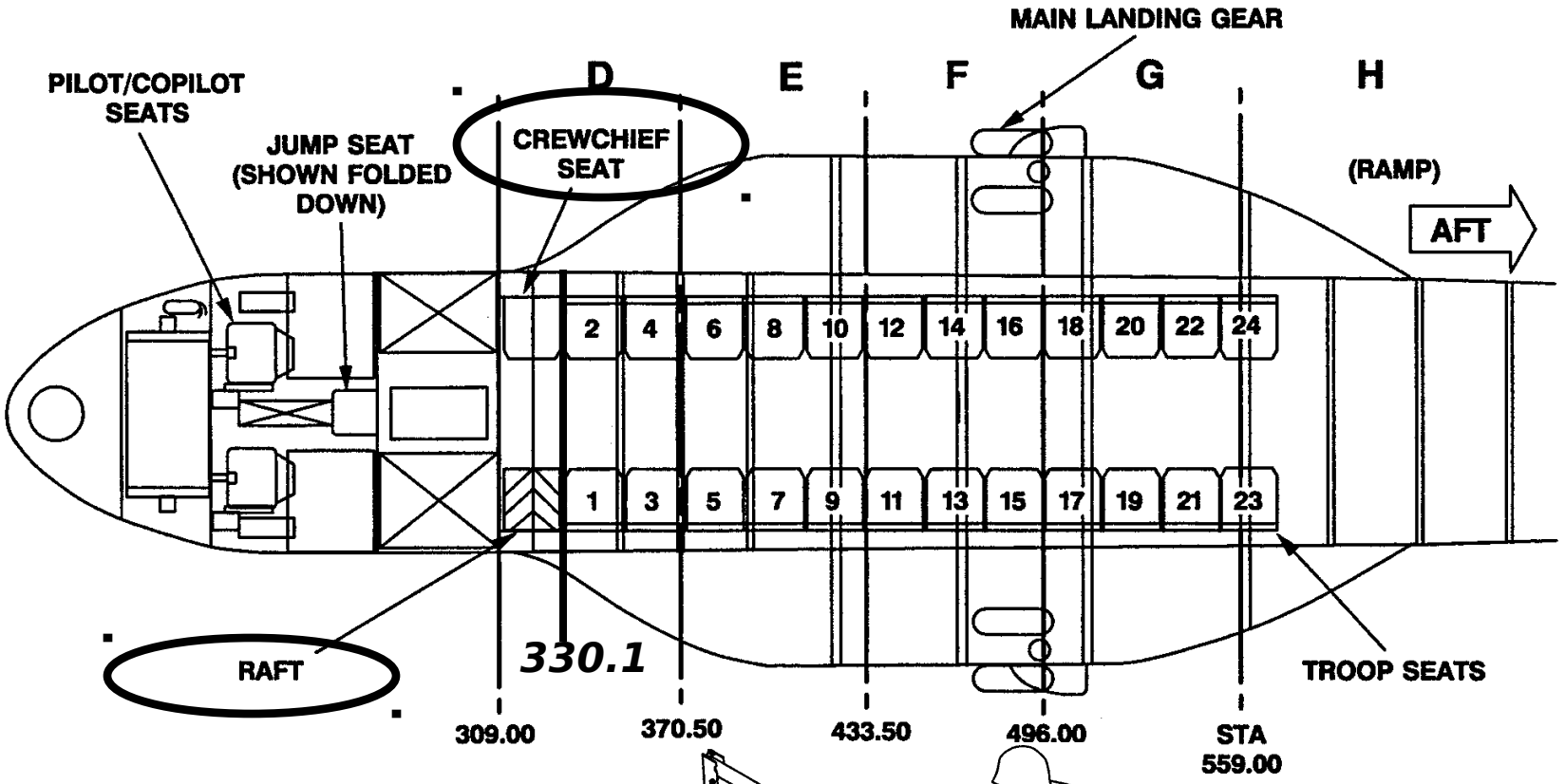
- driver does not have total control over vehicle

The turned tire, being outside the OML of the vehicle while making small alignment adjustments on the ramp and cabin causes increases workload to the aircrew. More eyes are needed to watch all the critical strike areas in the cabin or a slower loadex evolution occurs.

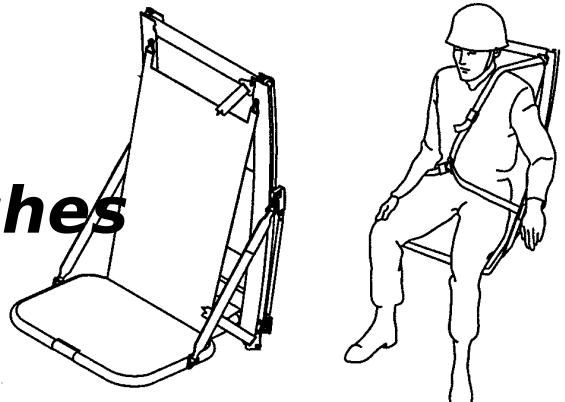


BREAK-OVER ANGLE – RELATES TO HEIGHT TO STRIKE CARGO ENVELOPE

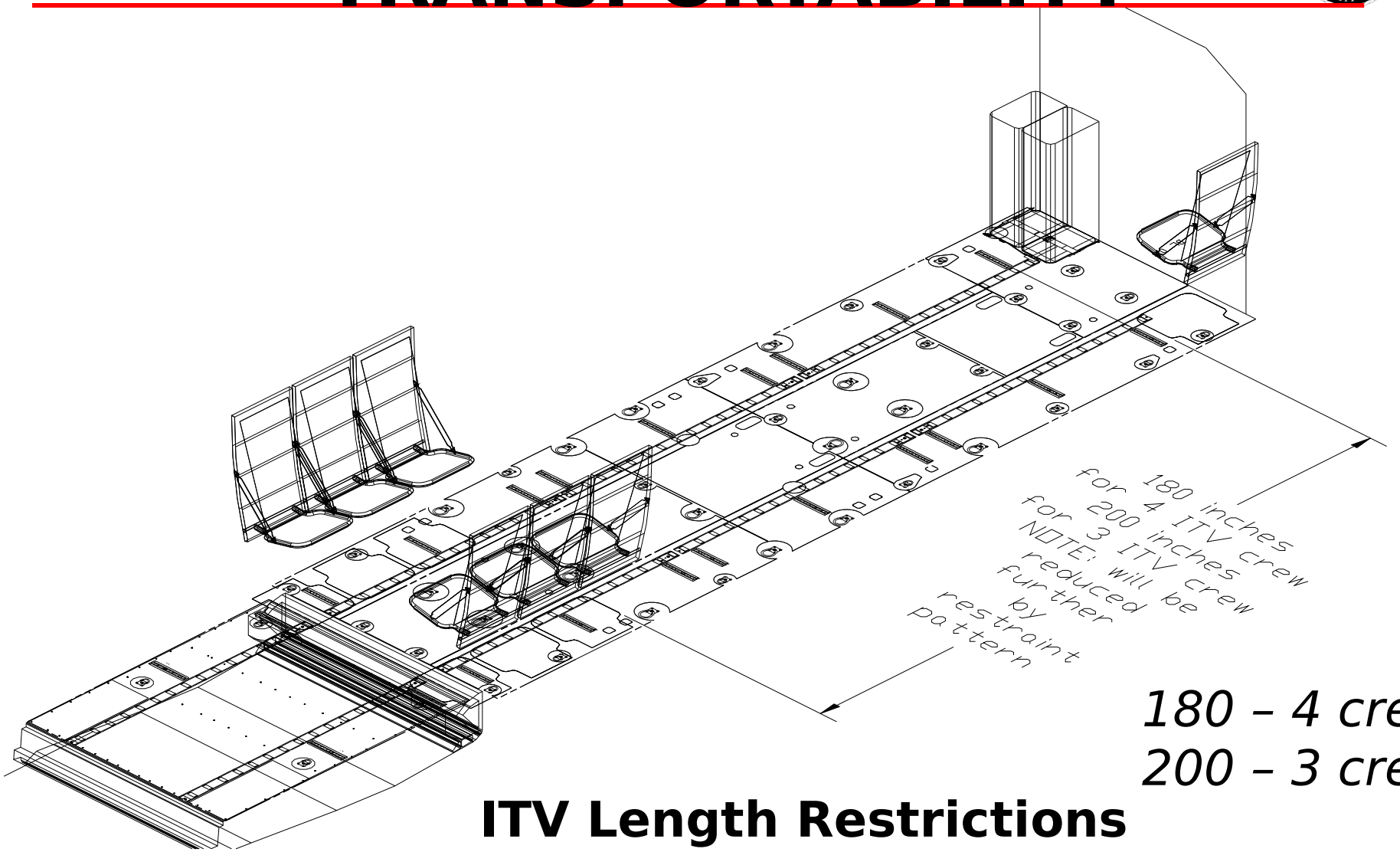
V-22B - ITV TRANSPORTABILITY



One seat to the next - 20 inches



V-22B - ITV TRANSPORTABILITY



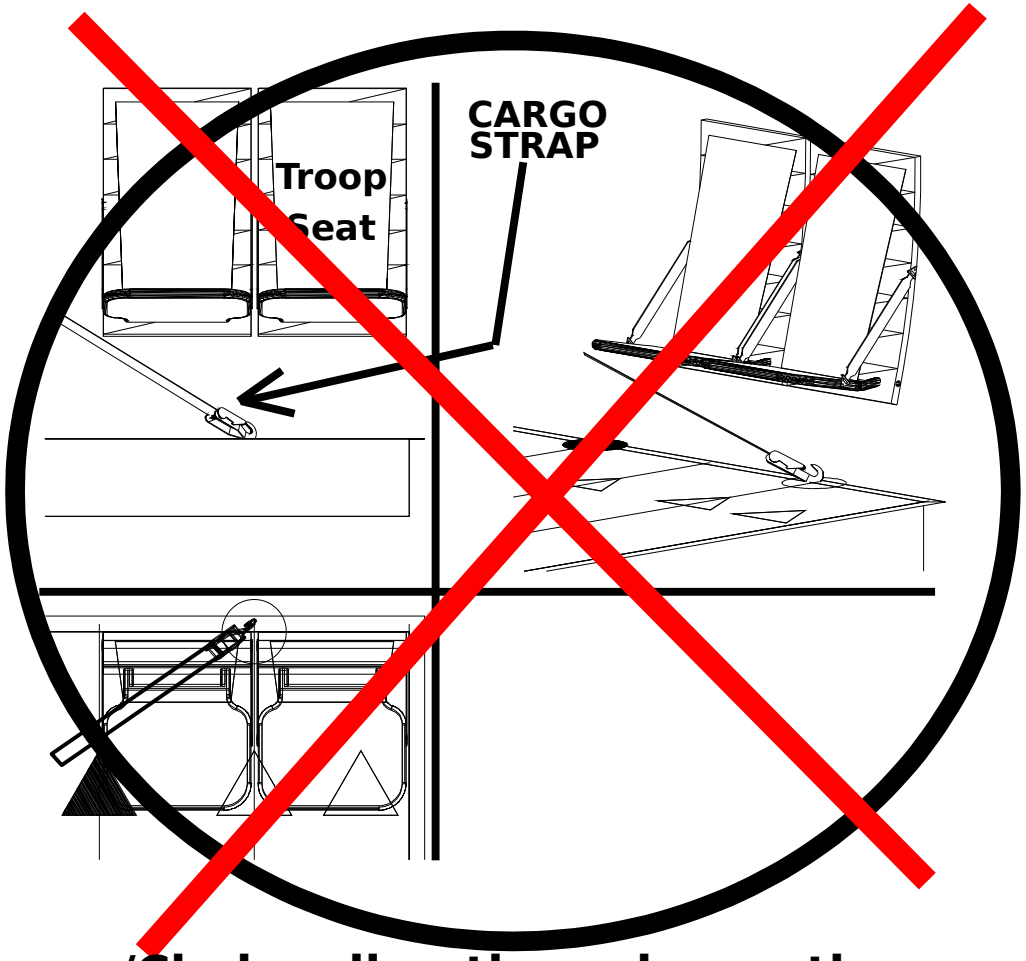
180 – 4 crew

200 – 3 crew

ITV Length Restrictions

180 or 200 less tiedown restraint angles, ring accessibility and CG Placement

V-22B - ITV TRANSPORTABILITY



Straps/Chains directly underneath an occupi
seat or a path under the occupied seat is proh

V-22B - ITV TRANSPORTABILITY

CENTER OF GRAVITY

- *Must comply with CG for both driven-in and backed-in conditions*
  - *Vehicle Length has potential of being reduced for this compliance*
- *CG compliance will not be based on the "dumping" of goods*
  - *Anticipate the "abort" of the vehicle mission immediately after exiting the aircraft*

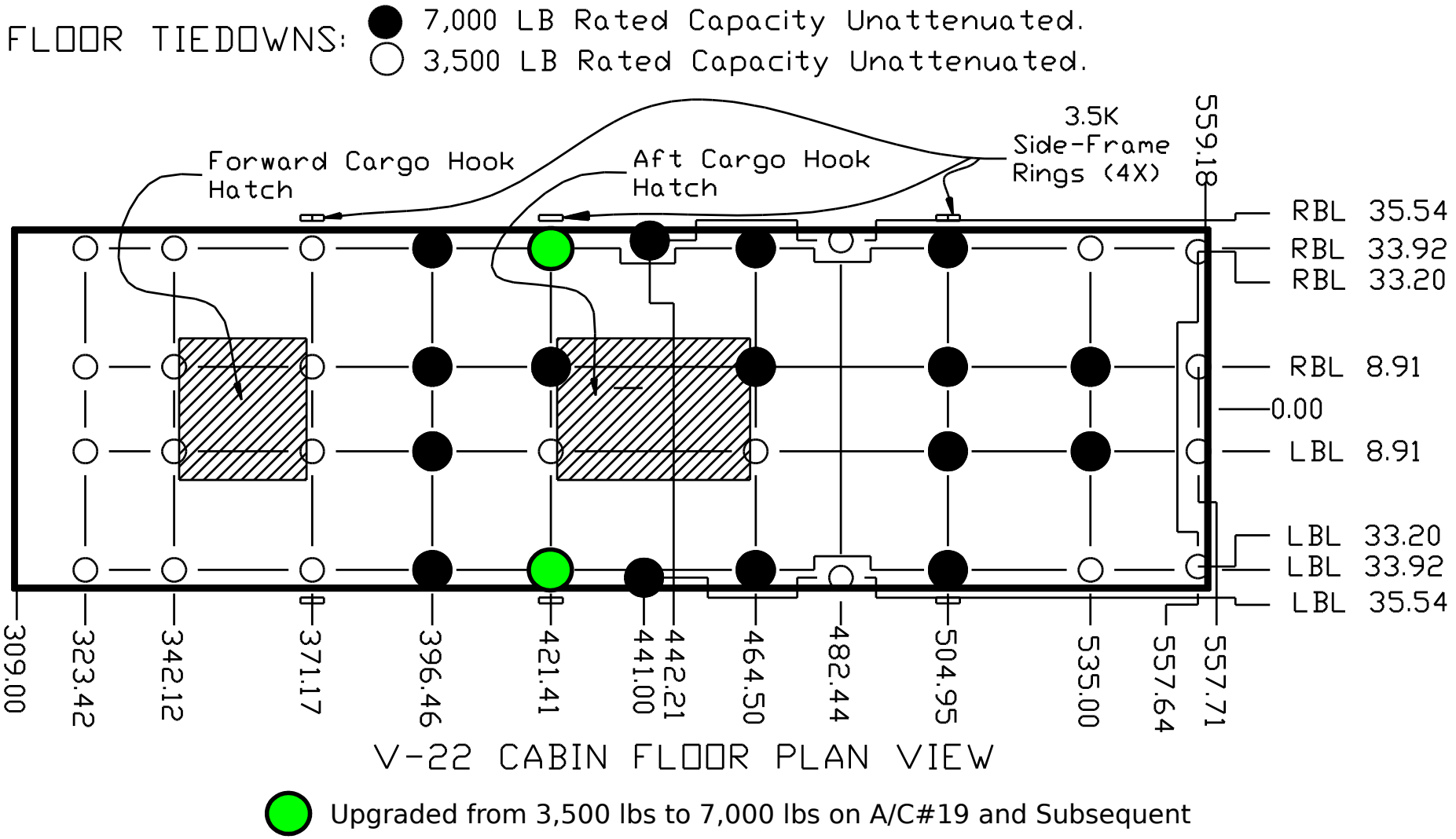
V-22B - ITV TRANSPORTABILITY

Placeholder for CG Charts

V-22B - ITV TRANSPORTABILITY

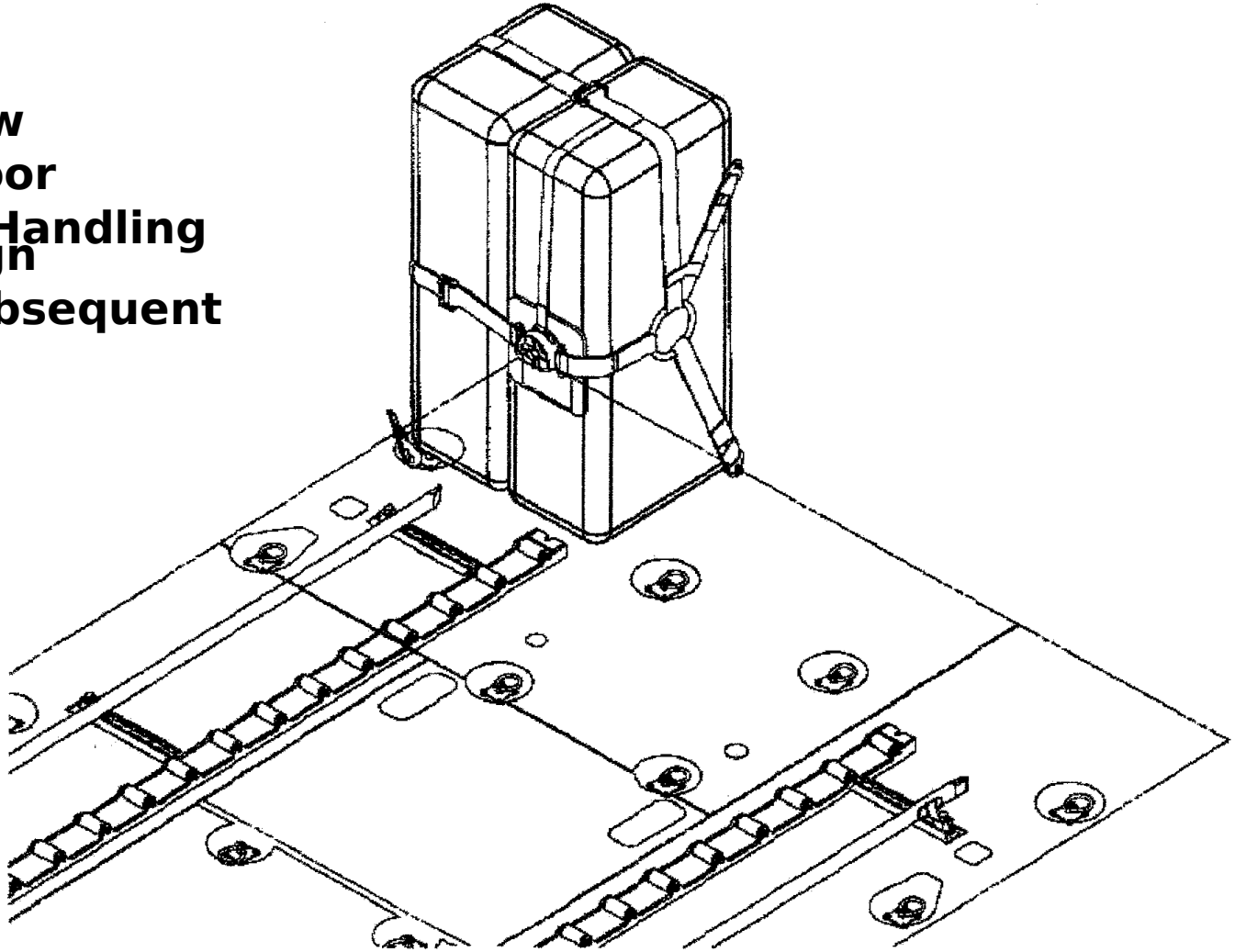
Placeholder for CG Charts

V-22B - ITV TRANSPORTABILITY

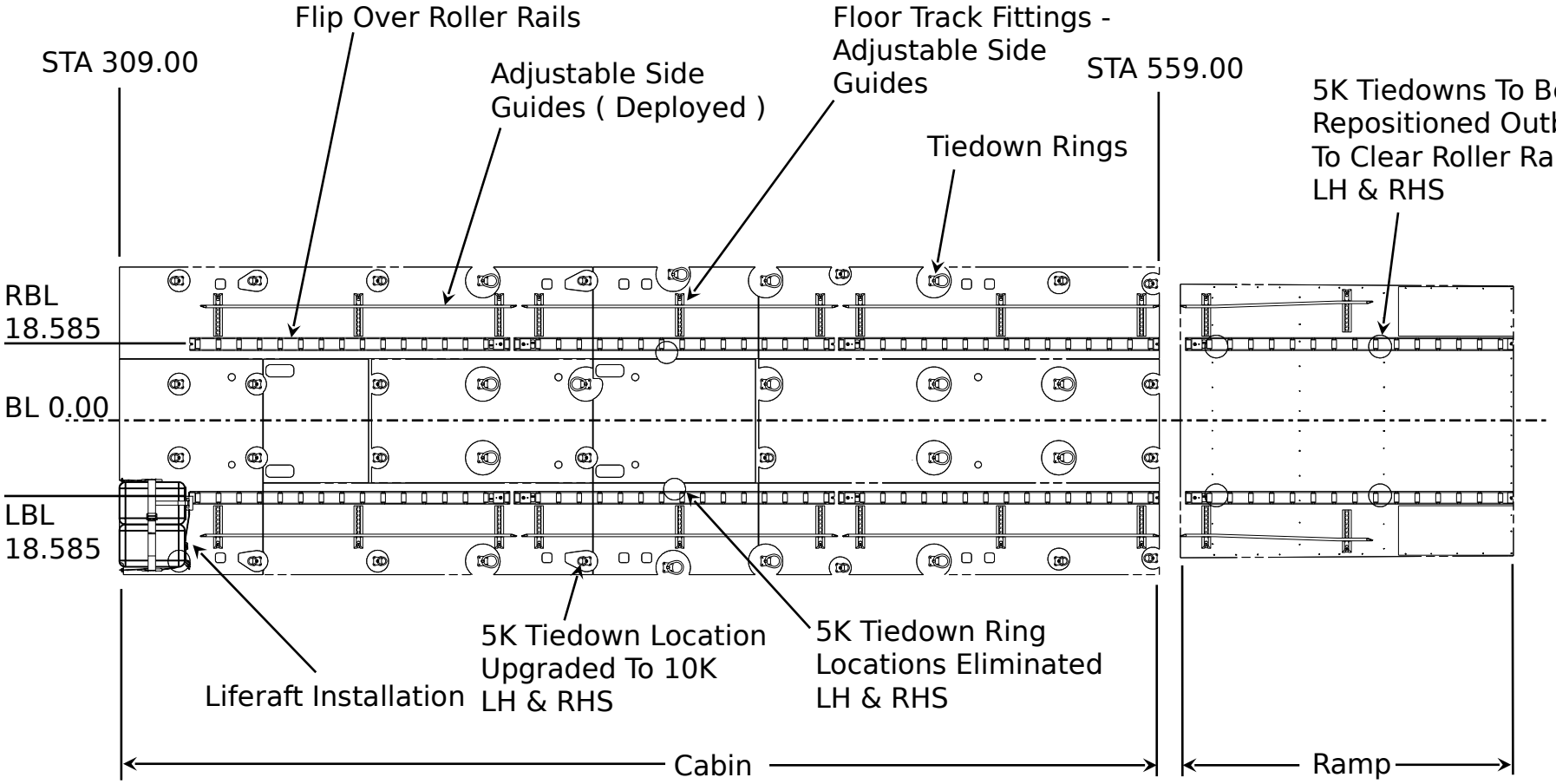


V-22B - ITV TRANSPORTABILITY

ISO View
Cabin Floor
Internal Load Handling Redesign
A/C#19 and Subsequent



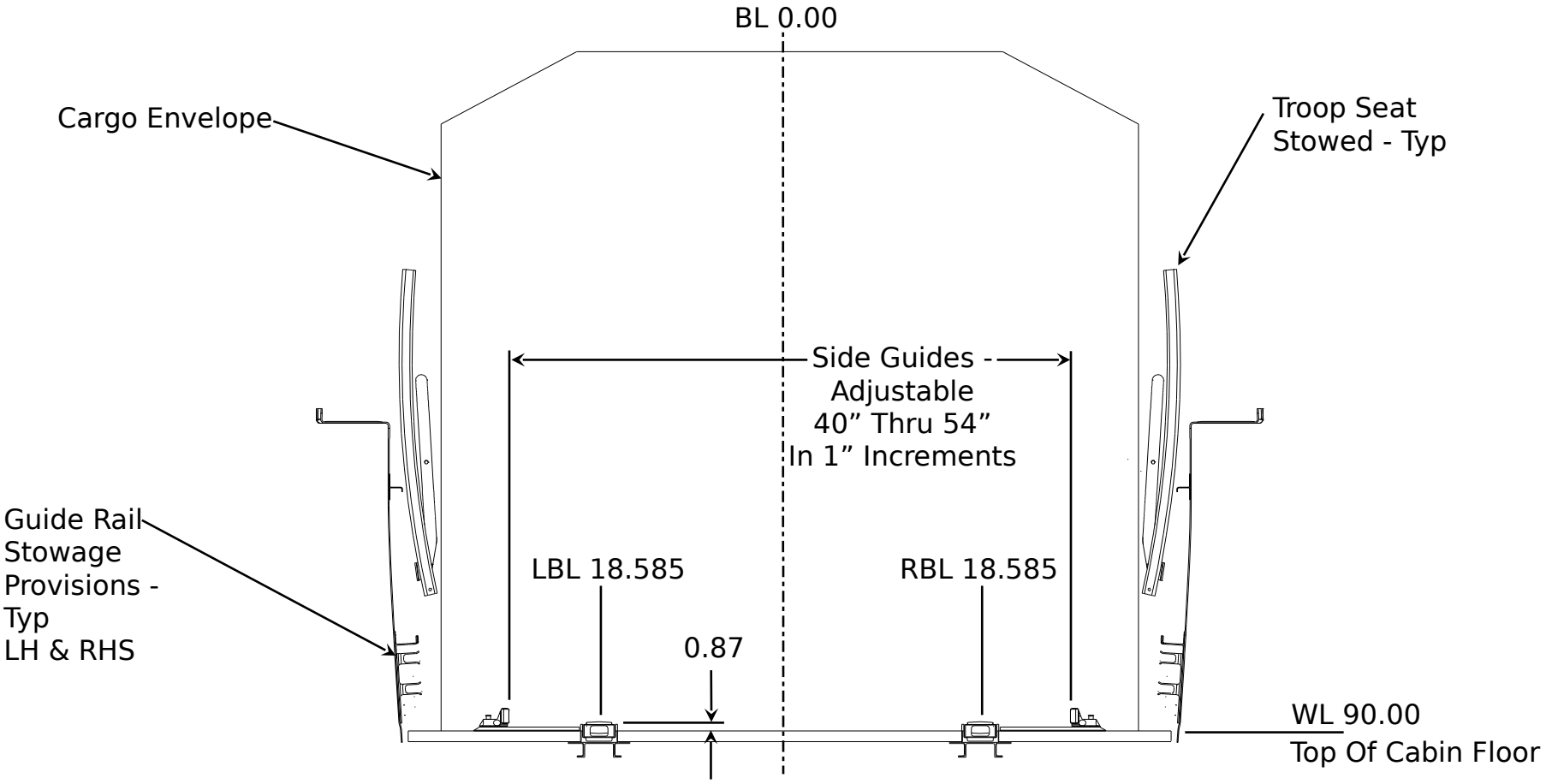
V-22B - ITV TRANSPORTABILITY


Flip Over Roller Rails
STA 309.00
Adjustable Side Guides (Deployed)
Floor Track Fittings - Adjustable Side Guides
STA 559.00
Tiedown Rings
5K Tiedowns To Be Repositioned Outbd To Clear Roller Rails LH & RHS
RBL 18.585
BL 0.00
LBL 18.585
Liferaft Installation
5K Tiedown Location Upgraded To 10K LH & RHS
5K Tiedown Ring Locations Eliminated LH & RHS
Cabin
Ramp
FWD

Plan View
Cabin & Ramp Floor
Internal Load Handling
Redesign

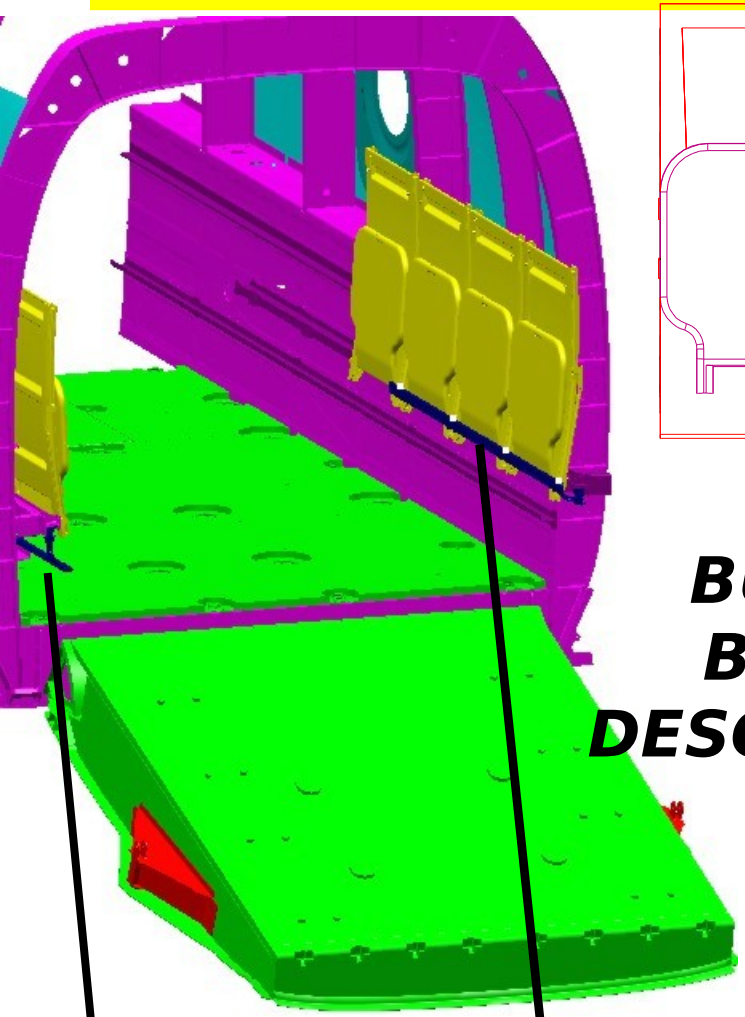
(A/C#19 and Subsequent)

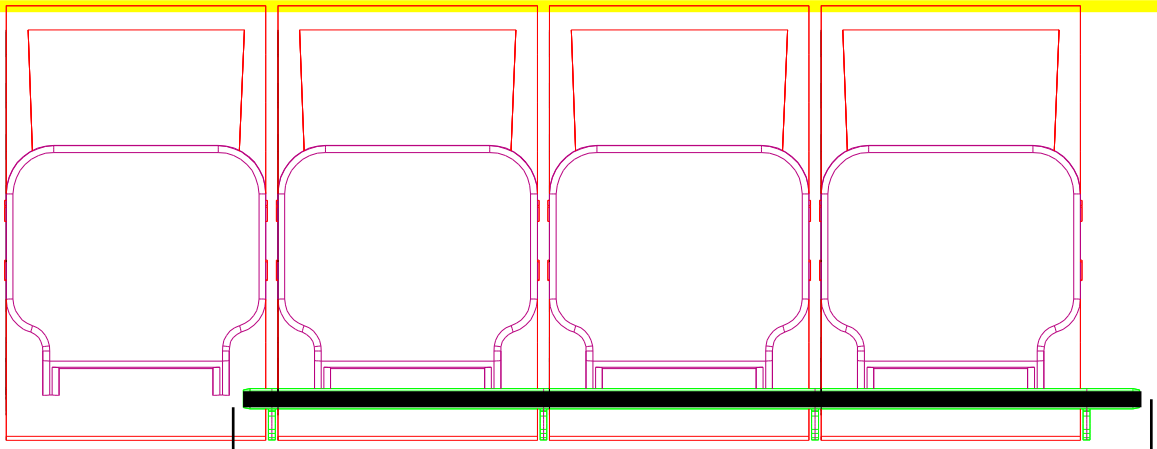
V-22B - ITV TRANSPORTABILITY



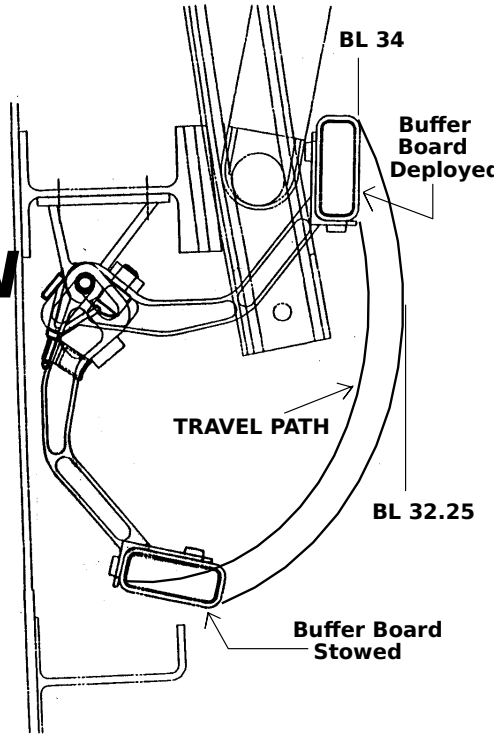
View Looking Forward
Deployed Roller Rails & Guides
Internal Load Handling Redesign

V-22B - ITV TRANSPORTABILITY



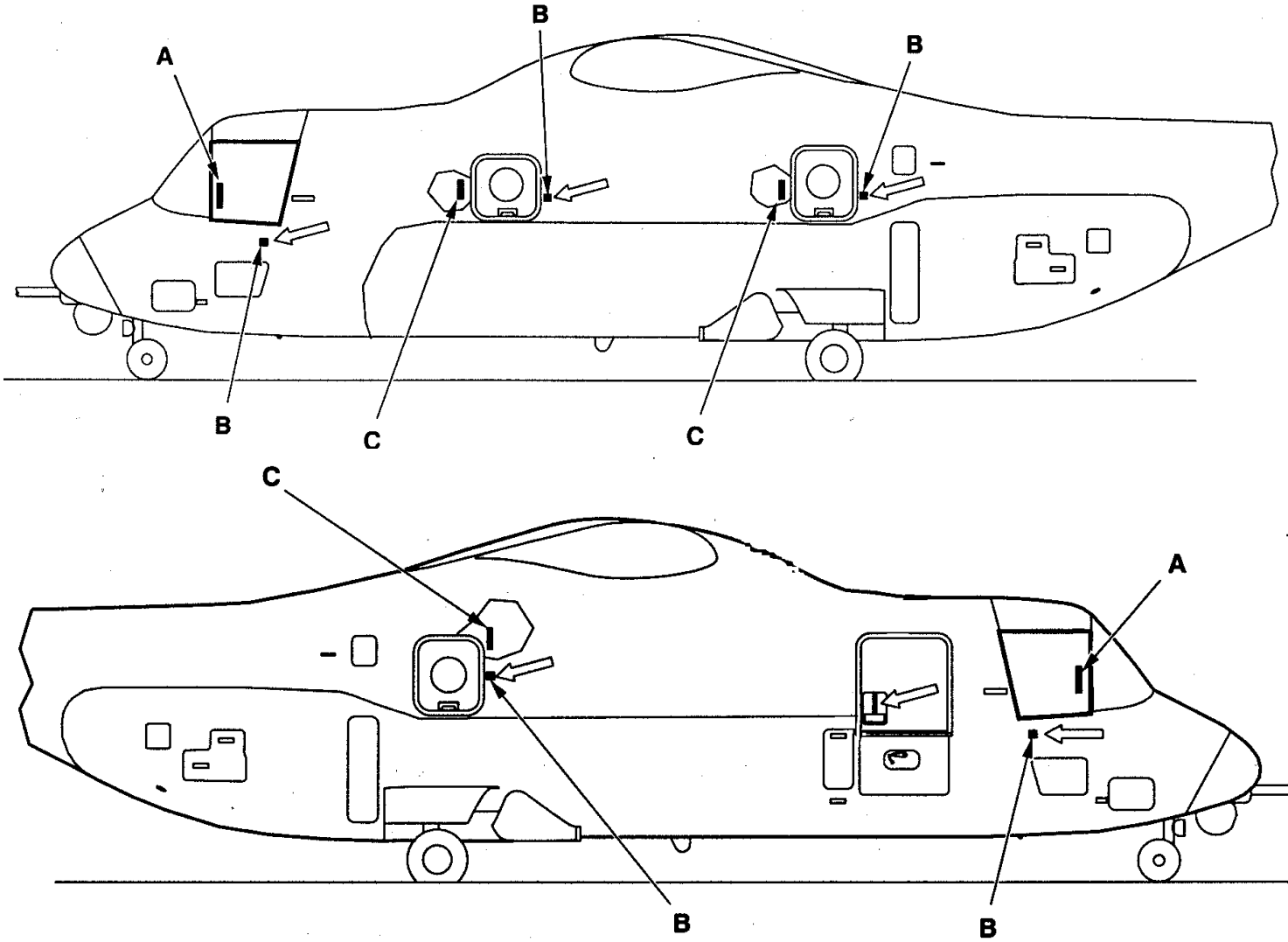


BUFFER BOARD DESCRIPTION



V-22B - ITV TRANSPORTABILITY

V-22B EMERGENCY EXITS

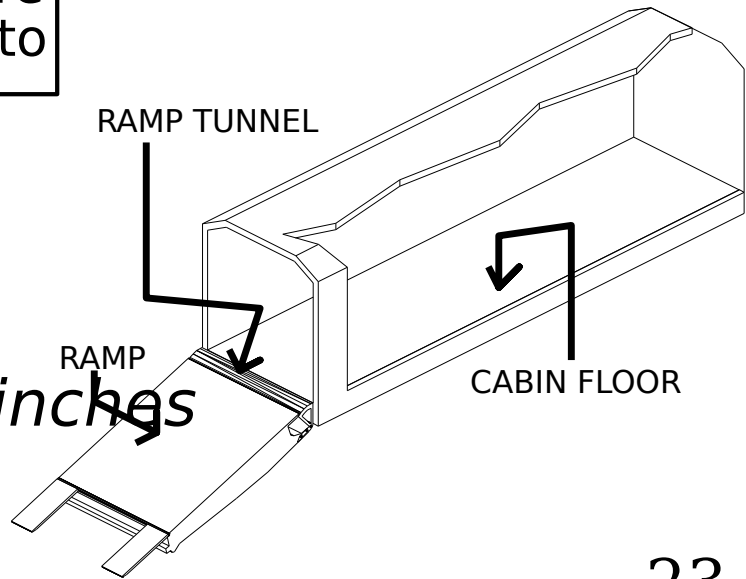


V-22B - ITV TRANSPORTABILITY

V-22 FLOOR DEFINITION

V-22 Baseline Floor Capability	
Cabin Floor & Ramp Tunnel	≤ 2450 lbs per axle ≥ 48 inches between axles ≤ 17 psi floor contact pressure > 36 inches wheel track (ctr to
Ramp	≤ 1800 lbs per axle ≥ 32 inches between axles ≤ 25 psi floor contact pressure > 36 inches wheel track (ctr to

ITV - ENVELOPE
1800 lbs / 48 inches / 17 psi / 36 inches



V-22B - ITV TRANSPORTABILITY

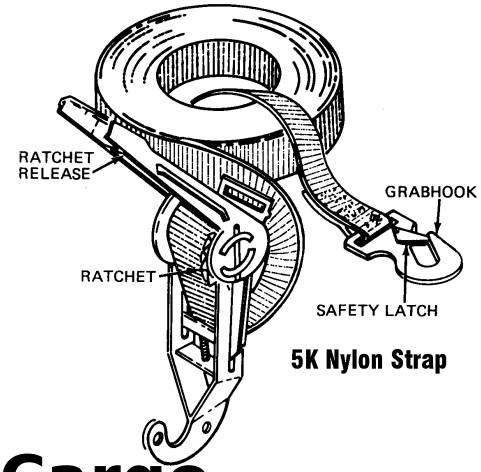
THREE AXLES

- *The front axle shall maintain in contact with the cargo floor to provide steering capability*
- *No single axle can be "off-loaded" during the loading portion such that the cabin/ramp limits are exceeded on the other axles*

V-22B - ITV TRANSPORTABILITY

- **V-22 Restraint Criteria (as published in the V-22 Cargo Loading Manual)**
  - 8G Forward
  - 3.0G Aft
  - 3.0G Lateral
  - 2G Up

  NOTE: Static Load Factors Defined as Limit Load Apply a 1.5 factor for Ultimate



- **V-22 Restraint Criteria when NAVAIR Cargo Restraint Policy Change is completed**
  - 4.0G Forward
  - 3.0G Aft
  - 3.0G Lateral
  - 3.0G Up

  NOTE: Static Load Factors Defined as Limit Load Apply a 1.5 factor for Ultimate

V-22B - ITV TRANSPORTABILITY

- **NAVAIR 4.3.5.4 reviewed the current guidelines for tiedown provisions and their testing (MIL-STD-209) during the Cargo Restraint Reduction Policy Change**
  - MIL-STD-209 does not correlate with the instructions contained in the Cargo Loading Manual of all airframes
    - No cone of action determination thru MIL-STD-209
    - MIL-STD 209 and its testing supports only uni-directional orthogonal restraint
      - Each load direction is “taken-out” in that pure pull direction
      - Each tiedown point would therefore need three (3) tiedown devices – each one would need to be pure lateral, pure vertical, pure longitudinal
    - Tiedowns are applied at angles (alpha/beta) to the floor and hence have resultant vectors
    - Test methods for 209 compliance in some directional pulls only test the provision and very local backup structure without tracing load path back into main members.

V-22B - ITV TRANSPORTABILITY

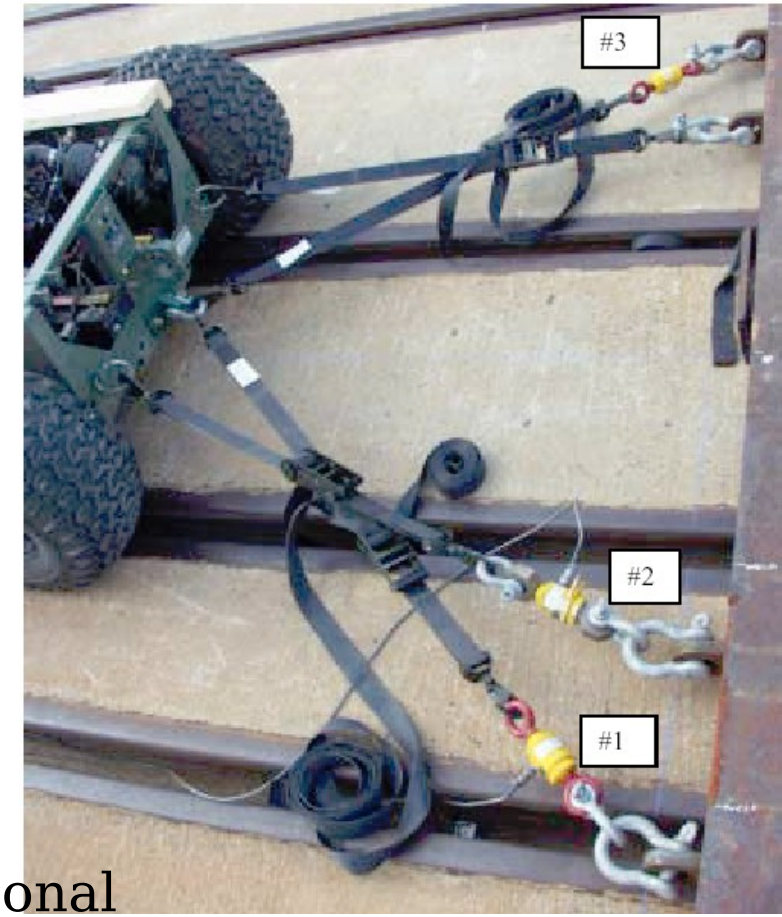
ATC – Typical Test - Forward/Aft to MIL-STD

V-22B - ITV TRANSPORTABILITY

ATC – Typical Test - Lateral to MIL-STD 209

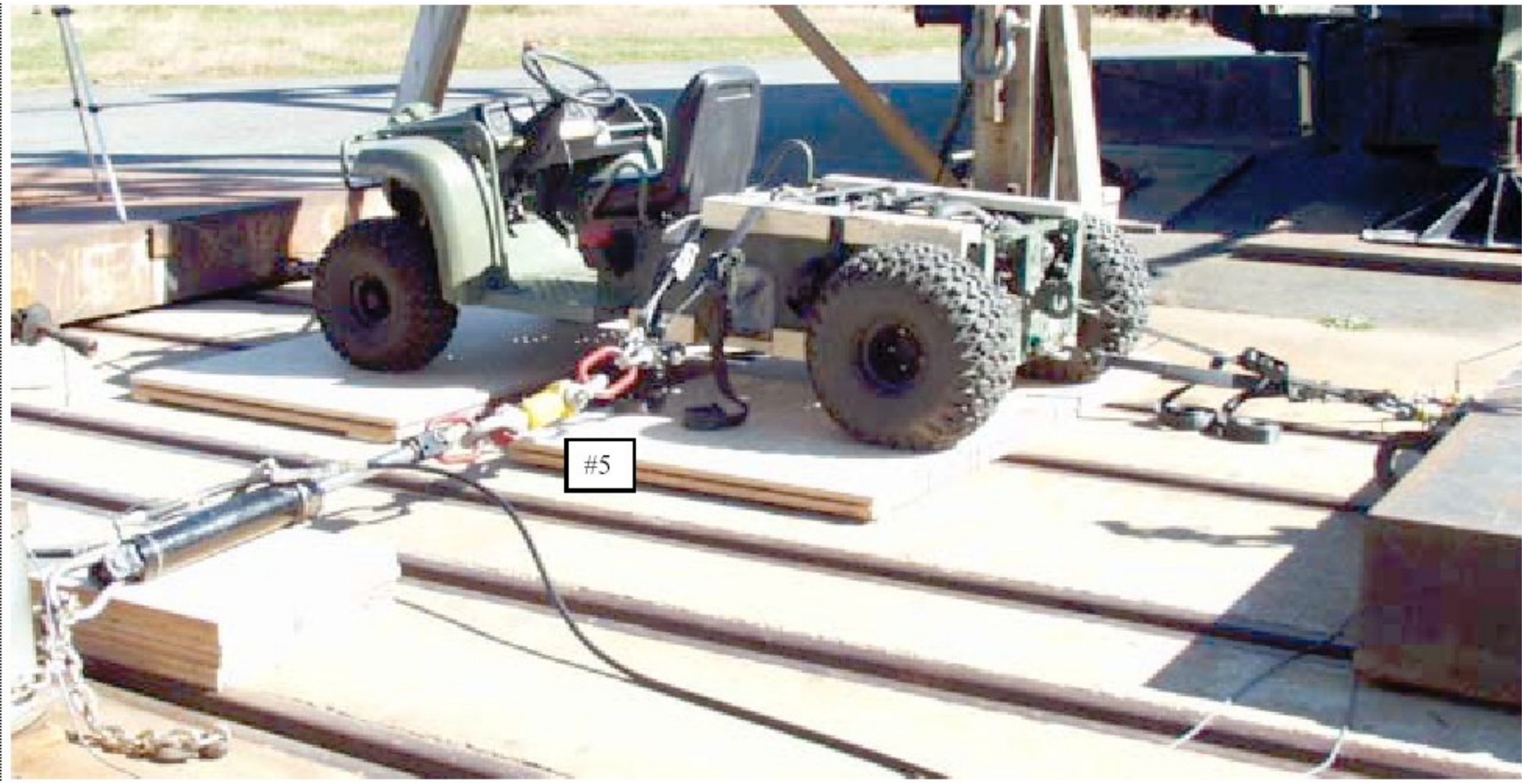
- Proves only that the provision is good and not the entire backup structure into the bumper and chassis --- does nothing to see if

NAVAIR - Test - Forward or Aft to Cargo Manu



- Input G load is uni-directionally/orthogonal
- Reaction Loads build up in their resultant vector format as they would on an aircraft

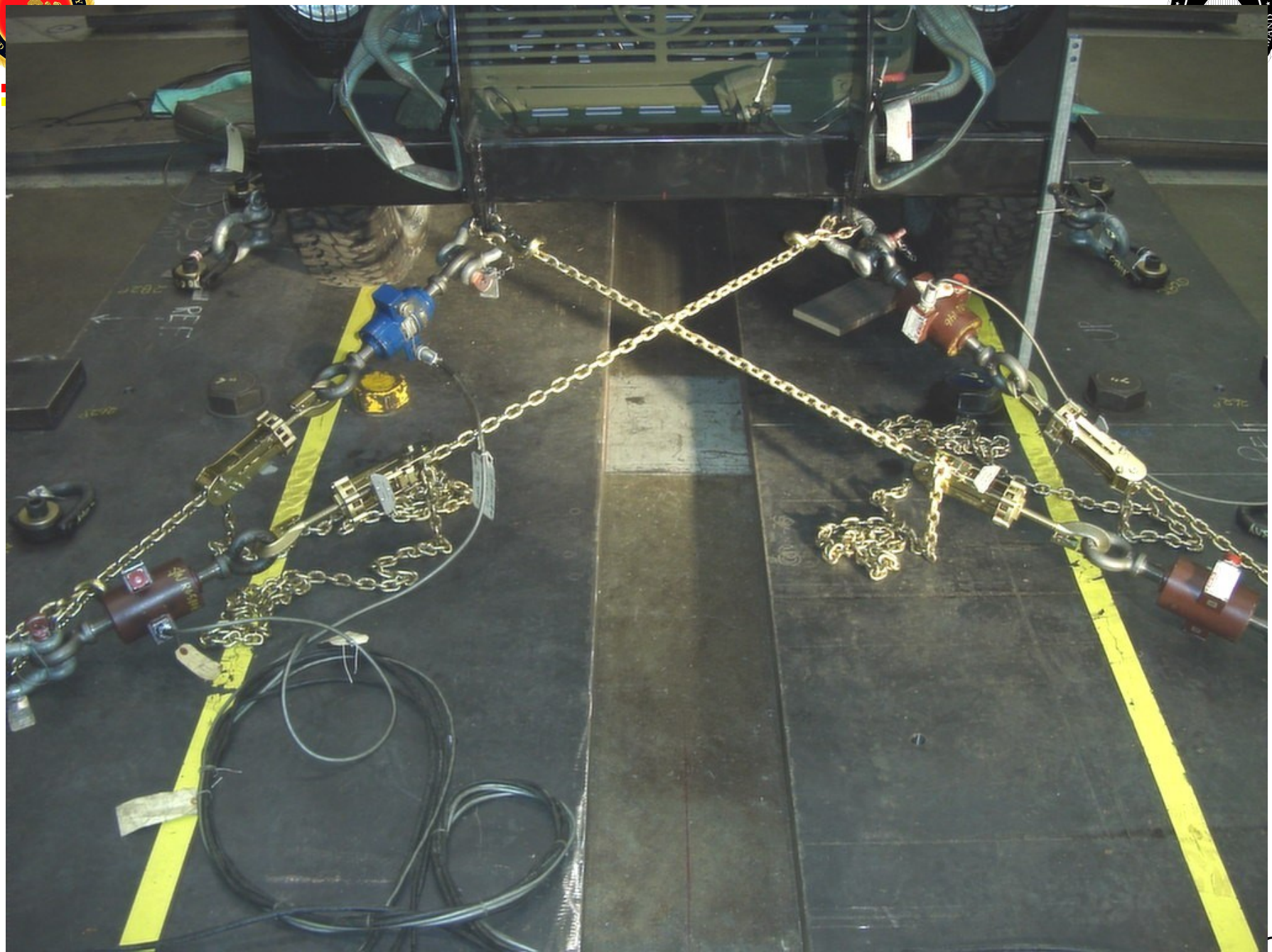
NAVAIR – Test - Lateral to Cargo Loading Manu



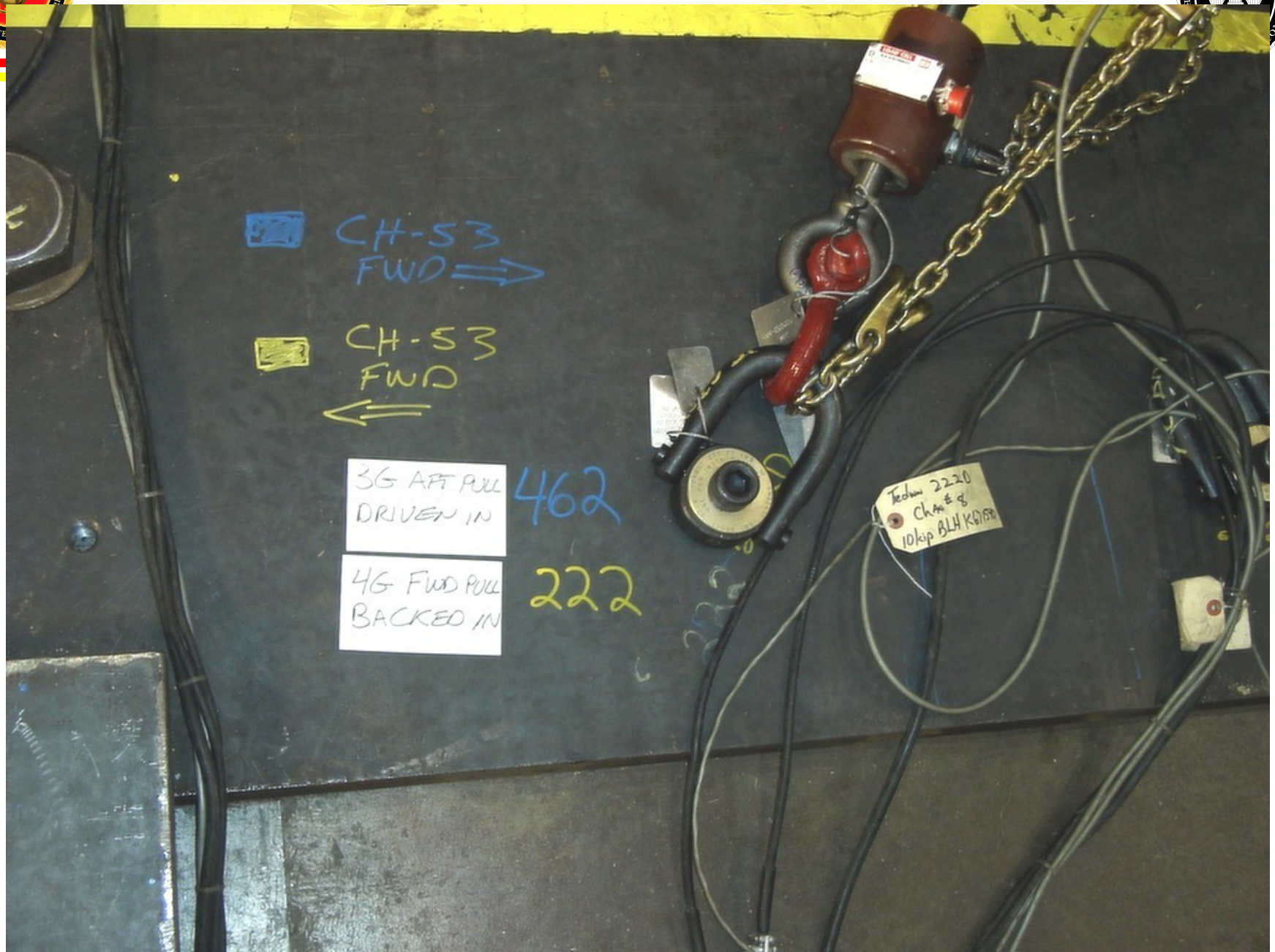
- Input G load is pulled at or close to the Center of Balance of the Vehicle
- Reaction Loads build up simultaneously as they would on an aircraft

RECENT IFAV TESTING to CARGO MANUAL

RECENT IFAV TESTING to CARGO MANUAL



RECENT IFAV TESTING to CARGO MANUAL



LATERAL TESTING

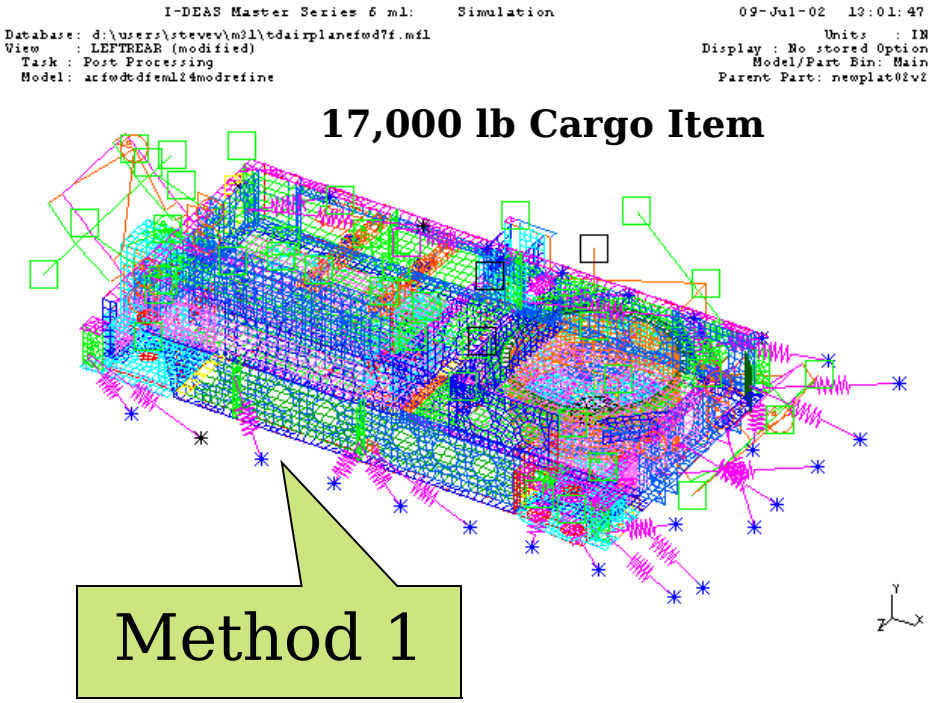
V-22B - ITV TRANSPORTABILITY

NAVAIR working with tri-service to gain unity on method of acceptance of tiedown provision analysis/testing

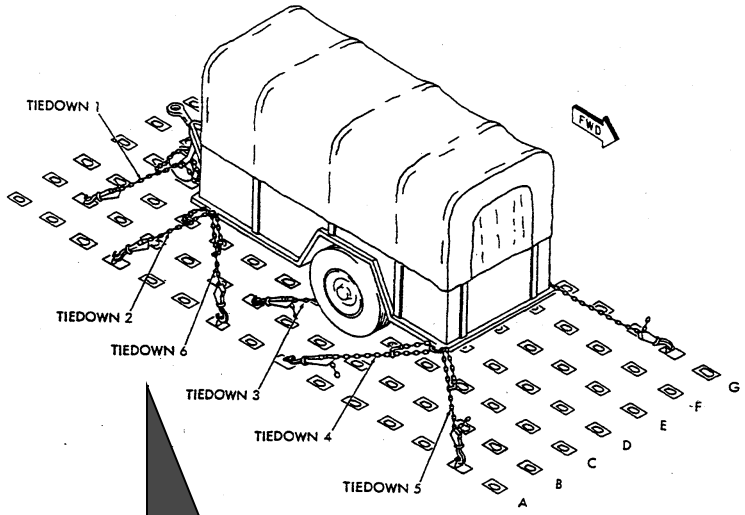
- *To be 209J compliant does not mean you are NAVAIR compliant*
- *Until unity is achieved, NAVAIR will work to specific tiedown patterns , and perform total tiedown pattern testing.*
  - *Limits the fleet in their flexibility*
  - *But does it - in smaller aircraft like the V-22 and CH-53 ?*
  - *Twenty inch grid patterns on C-130's mean a repeatable vehicle tiedown pattern that can be tested and defined ?*
  - *In the end - cone of action is very important*

Cone of Action Approach by NAVAIR for MIL-STD-209

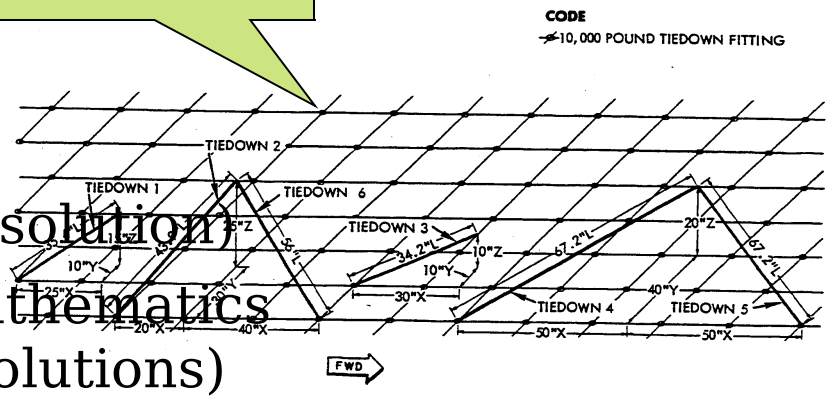
"Two method" approach to determining required strength of provisions and back-up structure



Method 1



Method 2



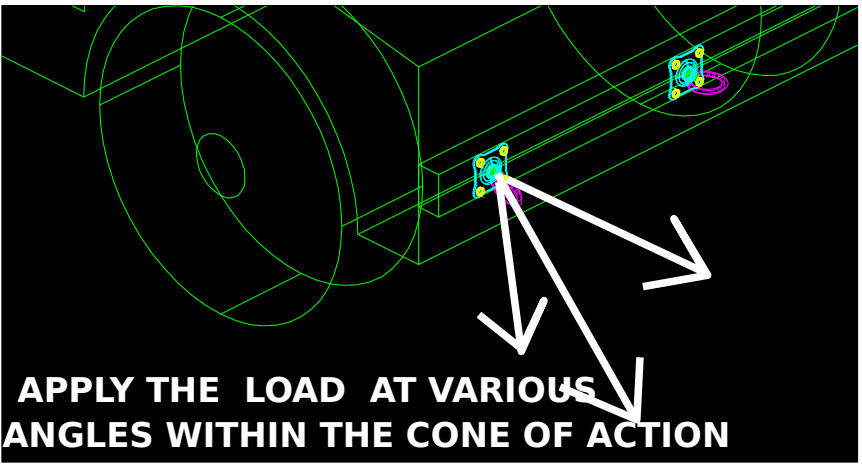
Method 1 = Precise Engineering (one solution)

Method 2 = Cargo Loading Manual Mathematics

Aircrew Flexibility (multiple/finite solutions)

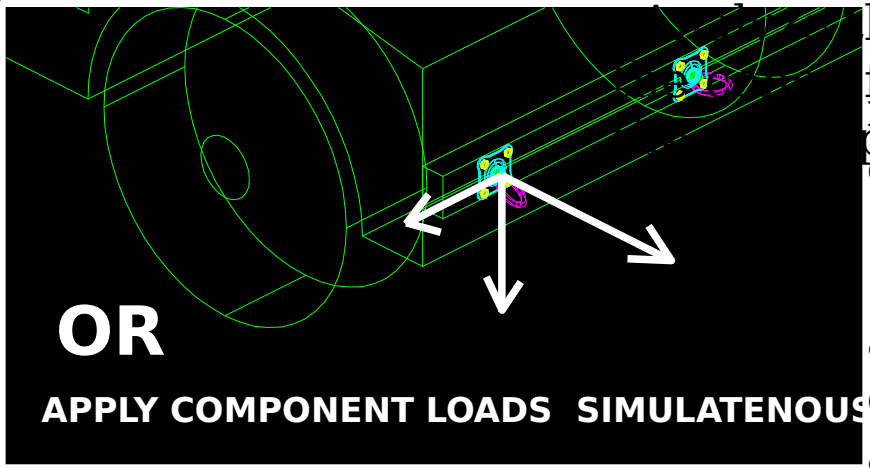
GOAL: Method 1 feeds into Provision Design to Support Method 2

CONE OF ACTION ANALYSIS / PULL TEST (NC



•Increase reaction load into provision / backup structure from Method 1 to the nearest 5,000 lb increment and design the structure for that reaction load to support Method 2.

•The provision/backup structure will be required to have no loss of strength in the defined cone of action



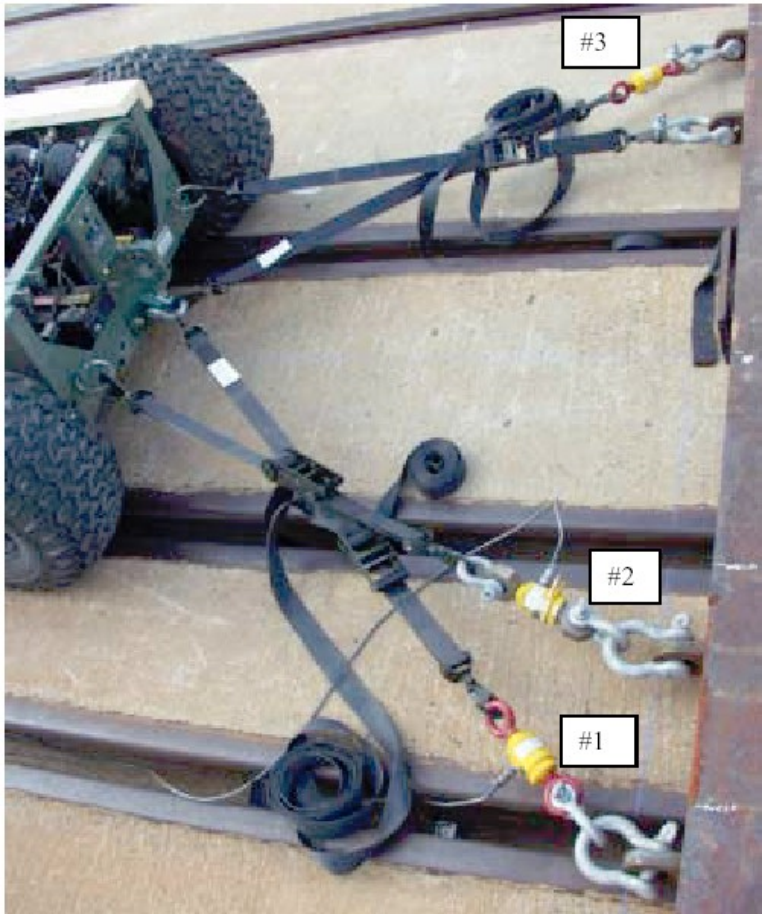
he reaction load thru
f action to determine
four points in that
possible cases.

•Pull test to at least
cone.

•Test Loads may be applied at the angles or component loads applied

Total Tiedown Pattern Analysis / Testing

- Validates simultaneous reactions of all tiedowns into the backup structure
  - Completed on John Deere G



Analysis and Static/Rail Impact Testing For Vehicle Sub-Components and Truckbed “Cargo”

- Will the front rank containing the water cans be capable of supporting the 4G FWD G Level ?
- Will the 50 CAL Gun and its Mount be able to sustain the 4G FWD Event ?
- Will all the ALCE Packs stay in place during the 4G FWD Event ?

RESTRAINT OF VEHICLE TO 4G IS USELESS UNLESS TOTAL VEHICLE “SYSTEM” ALSO COMPLIES

V-22B - ITV TRANSPORTABILITY

- *Be there on time !*
- *Be mindful of those who go after you !*
- *Not allowed in the mockup/lab until your timeslot*
- *Have your vehicle ready outside the garage door*

We Are here to SUPPORT YOU

- *Crew chiefs*
- *Flight Engineers*
- *Special Tactics*
- *NAVAIR Functional*

TIMESLOTS ON THE V-22 MOCKUP